HYDROCARBON DEVELOPMENT IN THE BEAUFORT SEA-MACKENZIE DELTA REGION

JUNE, 1981

PREPARED BY

DOME PETROLEUM LIMITED

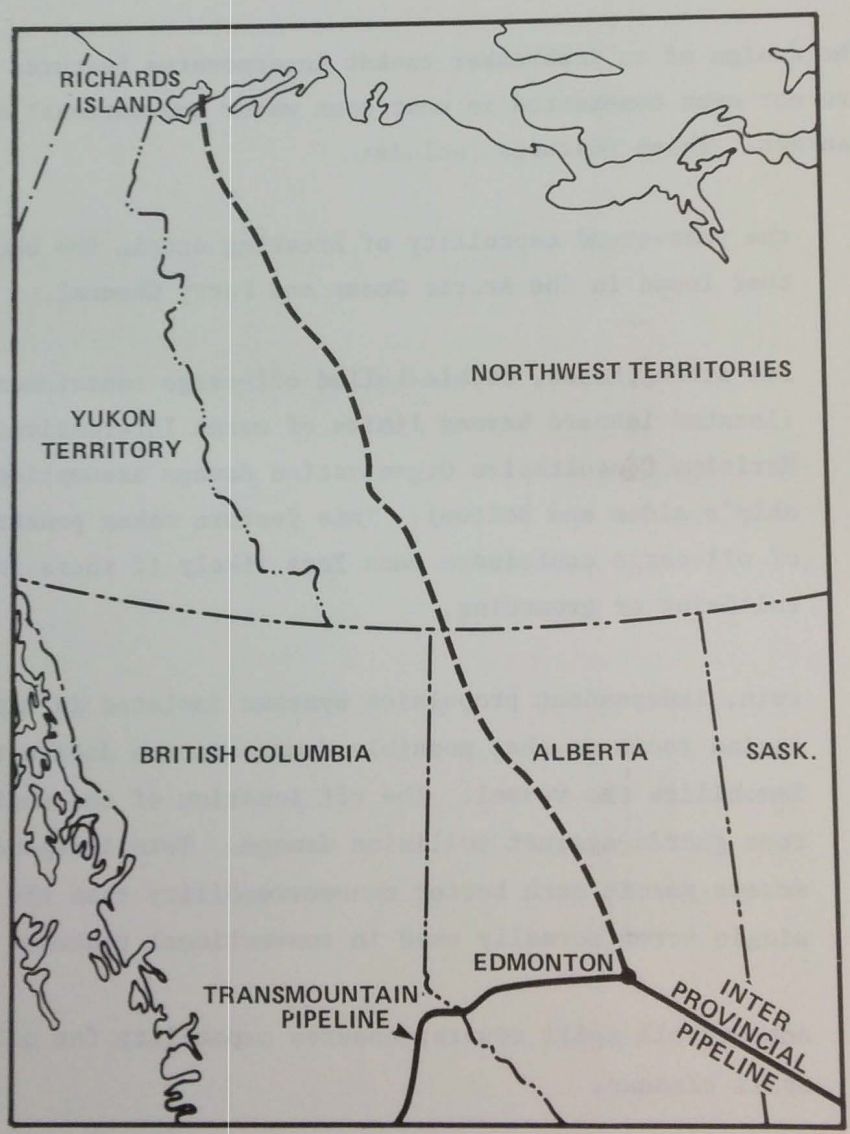
ESSO RESOURCES CANADA LIMITED

GULF CANADA RESOURCES INC.

/Environmental...

15

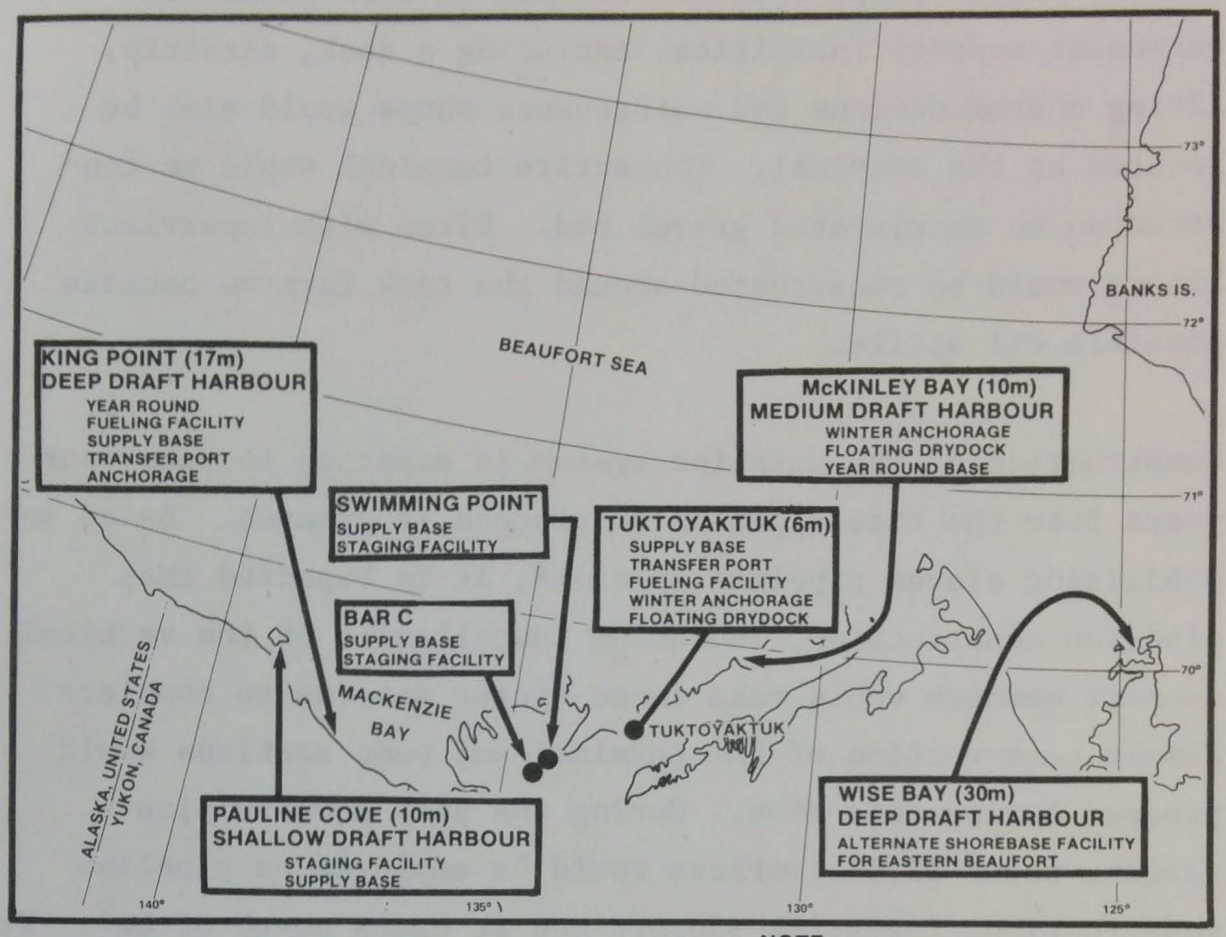
DOME'S ICEBREAKER KIGORIAK



16

RICHARDS ISLAND TO EDMONTON
PROPOSED OIL PIPELINE ROUTE MAP

EXPERIMENTAL BURIED AND RAISED OIL PIPELINE AT INUVIK



NOTE:
Other shore areas are expected to be required for pumping stations, processing plants, and pipeline right of ways.

FUNCTIONS OF HARBOURS AND SHOREBASES IN SUPPORT OF BEAUFORT SEA - MACKENZIE DELTA OPERATIONS 1980-2000

- a constant draft operation for stability using water ballast in between external and internal hulls and not in oil-cargo containers.

- independent, deep-well oil-pumping system for each separate cargo tank, to reduce in-hull piping and for better and safer cargo handling.

- forward mounted accommodation and navigation bridge for best forward visibility and crew safety.

The design concepts presented here are based on current knowledge, and expertise. As more research and field trial data accumulates, and as more experience is gained from the operation of the "Canmar Kigoriak" and other icebreaking ships, the design concepts will be modified as necessary to improve the final design.

Pipeline If a pipeline were used to transport Mackenzie Delta-Beaufort Sea crude oil to southern markets, it would extend almost 2,250 km (1400 mi.) from a northern Terminus on Richards Island to Edmonton, and would follow the general course detailed in Figure 16.

The design diameter of the pipeline, based on the assumed production scenario would be approximately 1067 mm (42 inches O.D.). When operating at maximum pressure of 1000 psi, with 24 pump stations located approximately 94 km (58 mi.) apart, the line would have a capacity of 255,000 m^3 (1,415,000 barrels) of oil per day. For the first two years of operation, only four pump stations would be required. However, as production increases over the following ten years, an additional twenty stations could be added. Each pump station would have an ultimate operating pumping capacity of approximately 21,000 kilowatts (28,000 horsepower).

Wherever geotechnical and environmental conditions are found acceptable, the pipeline would be buried using conventional construction techniques. In areas where conditions are not amenable to burial, the pipeline would be supported above the ground on steel supports called Vertical Support Members. Rivers and streams along the route would generally be traversed by burying the pipe in the stream bed. Based on the choice of a preliminary route and on geotechnical and pipeline design studies, approximately 720 km (450 mi.) of the pipeline would be elevated and insulated with fibreglass contained in an outer steel jacket. The remaining 1540 km (963 mi.) of pipe would be buried below ground. The pipeline will be constructed of steels combining good weldability with high strength and low temperature toughness.

The pump stations located in the N.W.T. would contain turbine driven pumps powered with fuel refined from the crude oil in small adjacent topping plants. Depending on location, the stations would be served by an airstrip or a permanent road and helipad. Personnel living accommodations would be available at those stations remote from northern communities. All pump stations would be designed for unattended remote control operation.

Valves to cut-off the flow of crude oil would be installed at river crossings and at other locations along the line so that average valve spacing does not exceed 24 km (15 mi.). These would be in addition to normal station valve requirements. The supervisory control system would be set up to shut down the pipeline system and selectively close remotely operated valves in the event that a leak was detected along the line.

Oil from offshore production platforms would be delivered by a subsea pipeline to a tank farm at the northern terminal of the pipeline. A small topping plant to provide fuel for the

turbine driven pumps would be located at this terminal. Permanent support facilities, including a dock, airstrip, living accommodations and maintenance shops would also be located at the terminal. The entire terminal would be constructed on an elevated gravel pad. Dikes with impervious liners would be constructed around the tank farm to contain possible oil spills.

Construction of the mainline system is expected to take four years from the time approval to proceed is granted. Based on mobilizing eleven pipeline spreads*, it is expected that pipeline construction, including installation of the vertical support members would take three winter seasons to complete. Summer construction of the terminal and pump stations would proceed during this time. During the peak construction season, about 12,000 workers would be employed on pipeline construction, logistics support and at camps north of 60^{o}. It is estimated that two million tonnes of materials, equipment and supplies would be moved into the N.W.T. during construction of the pipeline.

The pipeline system would be designed with a high degree of automation consistent with current industry practice. Accordingly, personnel and their permanent living accommodations would be concentrated at main operating bases with provisions being made for living accommodations at the pump stations for personnel required to carry out regular inspection and maintenance programs. In addition, these bases would maintain equipment and be staffed with trained personnel to respond to any emergency situations. The northern terminal would have a permanent staff to monitor and control incoming offshore oil and the mainline system.

---

* facilities, equipment and personnel required to work on a pipeline without additional support

When the pipeline is operating at full capacity, it is estimated that 300 people will be required for its operation and maintenance north of 60°.

Shorebases: Shorebases and harbours need to be strategically located for the efficient movement of people and material to exploration and production sites, and to minimize possible negative impacts. To date, at least 25 potential harbour sites along the Beaufort coastline have been evaluated by Industry and government. Presently five of these locations appear to be suitable for use by the oil industry (Figure 18). From west to east these include Pauline Cove and King Point in the Yukon and Tuktoyaktuk, McKinley Bay, and Wise Bay-Summers Harbour in the Northwest Territories.

McKinley Bay is currently used as an overwintering site for Dome's drillships and support vessels. The vessels are protected from offshore ice movements by an elongated artificial island. In 1981, Dome plans to build a dock on the inner face of the island and store drilling consumables on the island. Beyond 1981, the McKinley Bay site is expected to be transformed into a full-scale support base for year-round offshore operations. Although many of the activities may be accommodated at offshore Atolls, the Industry would expect McKinley Bay and at least one other coastal site to be used as year-round medium to deep draft harbours and service centres. In addition to these main harbours, there will be a need for protected deep water staging areas, where development components brought in from the south, such as caissons, platforms, etc., may be assembled and prepared for offshore installation. Sites which could be used for these purposes include Wise Bay-Summers Harbour and possibly Liverpool Bay.

Should offshore oil be brought to land by subsea pipelines, onshore storage and processing facilities will be required. The most likely sites for such development to take place would be located on Richards Island.

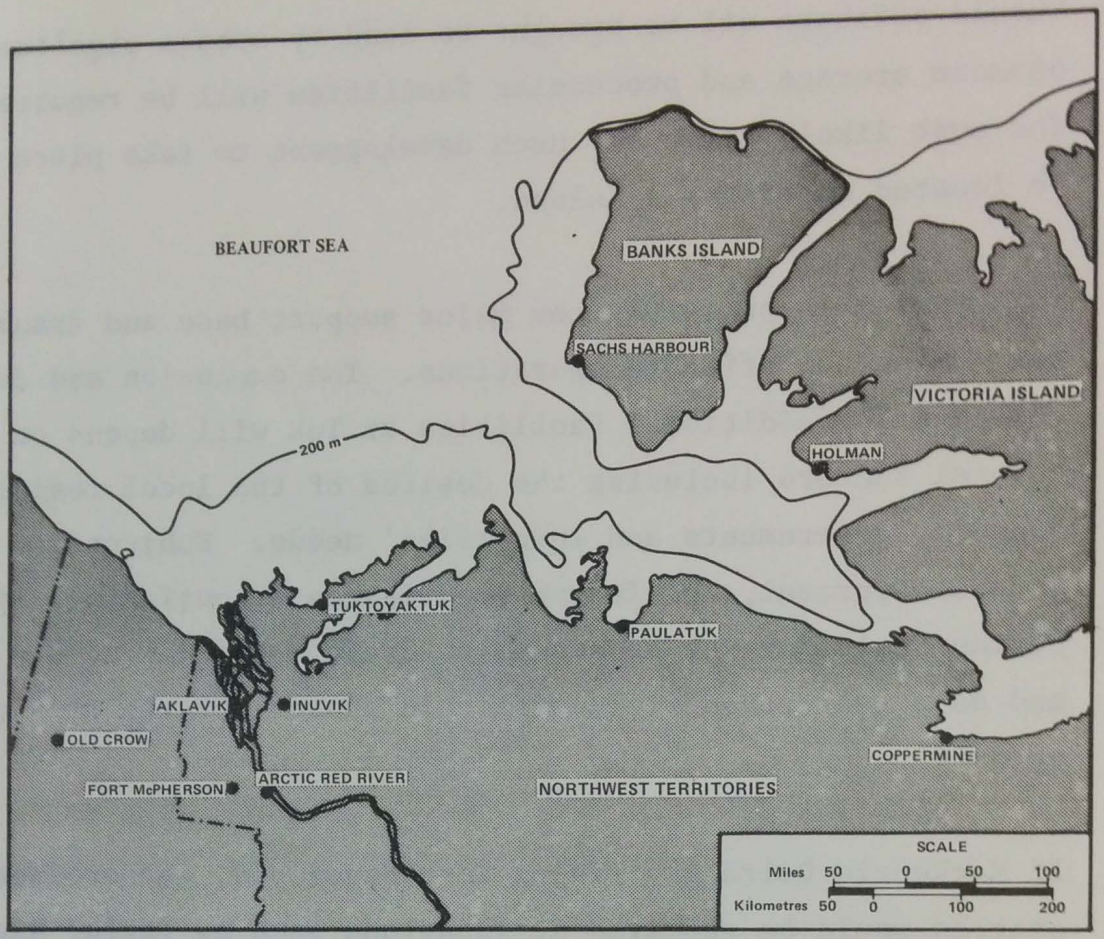
Tuktoyaktuk is presently the major support base and transshipment point for offshore operations. The expansion and development of additional facilities at Tuk will depend on several factors including the desires of the local residents, council, governments and industries' needs. Subject to general approval, the Industry envisages a continuing, important role for Tuk as a shallow draft, seasonal supply base and as a year-round field office in support of the offshore effort.

If Mackenzie Delta gas fields were developed, gas production centres would be required at locations such as Taglu, Niglintgak and Parsons Lake.

7. SOCIO-INFRASTRUCTURE

Major changes are projected in the character of Beaufort operations. There would be a shift from purely exploration to a mixture of exploration, development and production. Some operations which are now distinctly seasonal would become largely or entirely year-round. Both exploration and production would move further offshore. Most importantly from a socio-economic point-of-view, there would be a large increase in the scale of operations.

A labour force much larger than can be supplied by the local population would be needed to build and operate all of the projected facilities. As the labour force expands, an increasing fraction of it would be needed year-round rather than seasonal and would be housed in permanent northern communities rather than shuttling it to and from the south.



COMMUNITIES IN THE BEAUFORT SEA - MACKENZIE DELTA REGION

Depending on the desires of community residents and councils, the populations of some communities, particularly Inuvik and Tuktoyaktuk, could increase considerably by 1990. A total of 10,000 to 15,000 people could move into the area. Even more would be added by the year 2000. The temporary part of the labour force would be housed separately, ensuring minimum interference with community lifestyles. The more permanent part of the labour force would contribute to community growth. Along with this growth, there would be opportunities for local businesses and employment in the service industries. Jobs in the petroleum industry would create additional jobs in other community service sectors.

Permanent resident administrative personnel will be required in the Region with many of them coming from the south. It is anticipated that Inuvik would be the most appropriate location for this influx of people.

Timely social-infrastructure planning is necessary to ensure orderly community development. This planning will minimize interference with the preferred lifestyles of the northern peoples. It should also ensure that the areas and resources of importance to native harvesting are preserved and protected. Beyond this, the planning will provide the necessary management for social development and economic growth in keeping with the preferences of all northern peoples. With proper planning, the growth of some communities would provide a larger tax base to support better medical and social care, education and recreation.

Social-infrastructure planning and production-infrastructure planning are closely related in scale and scope. As production increases, so will the social-infrastructure. Planning should account for all the urban requirements of local residents commensurate with current Canadian standards. Responsibility for this planning rests with the Government of the Northwest Territories and

the Yukon, Community Councils, the Department of Indian and Northern Affairs and Industry. Within limitations, that may be imposed by governemt, Industry is prepared to take a leading role in the plan and its implementation. There is an opportunity for Government-Industry cost-sharing. For example, Industry could initially finance the building and operation of social-infrastructure facilities; later such costs could be borne by local and territorial governments as the tax base increases.

In summary, with proper planning, cooperation and good management, we believe there will be net positive socio-economic benefits for the region.

8 . TRANSPORTATION INFRASTRUCTURE

Large quantities of material will be required to support development in the Beaufort Sea-Mackenzie region between now and the year 2000. Some of these materials include fuel, drilling fluid additives, cement and pipe used in exploratory drilling, development drilling and the construction of production facilities and platforms.

The weight per year of consumables projected for the future are: 100,000 tons/yr in 1980-81, 300,000 tons/yr each year from 1982 to 1985 and 500,000 tons/yr each year from 1986 to the year 2000. The materials will come from all over the world and will be transported to the north by boats, ships and barges, aircraft and trucks.

Up to now, nearly all supplies are barged down the Mackenzie River during the summer. Some are trucked over the Dempster Highway during the winter, and some emergency supplies are flown in. The present capacity of the Mackenzie River transportation system is about 500,000 tons per year, which is not enough for the future although this capacity could be increased.

In the future, additional cargo could be delivered on a year-round basis using offshore icebreaking ships. The tankers which would carry oil cargo out of the north could be used to carry consumables on return voyages. On land, the Dempster highway traffic is likely to increase. For example, Dome is planning to transport barite mined in the Yukon over this highway to the Beaufort region by 1982 or 1983. Additional roads may be needed to link up shorebases such as Tuktoyaktuk with Inuvik.